

# NOAA'S National Weather Service

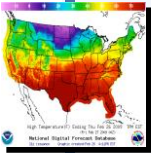
## Elite Concepts of *Severe Storm Spotting*

2011 – Rusty Kapela  
Milwaukee/Sullivan  
[www.weather.gov/mkx](http://www.weather.gov/mkx)



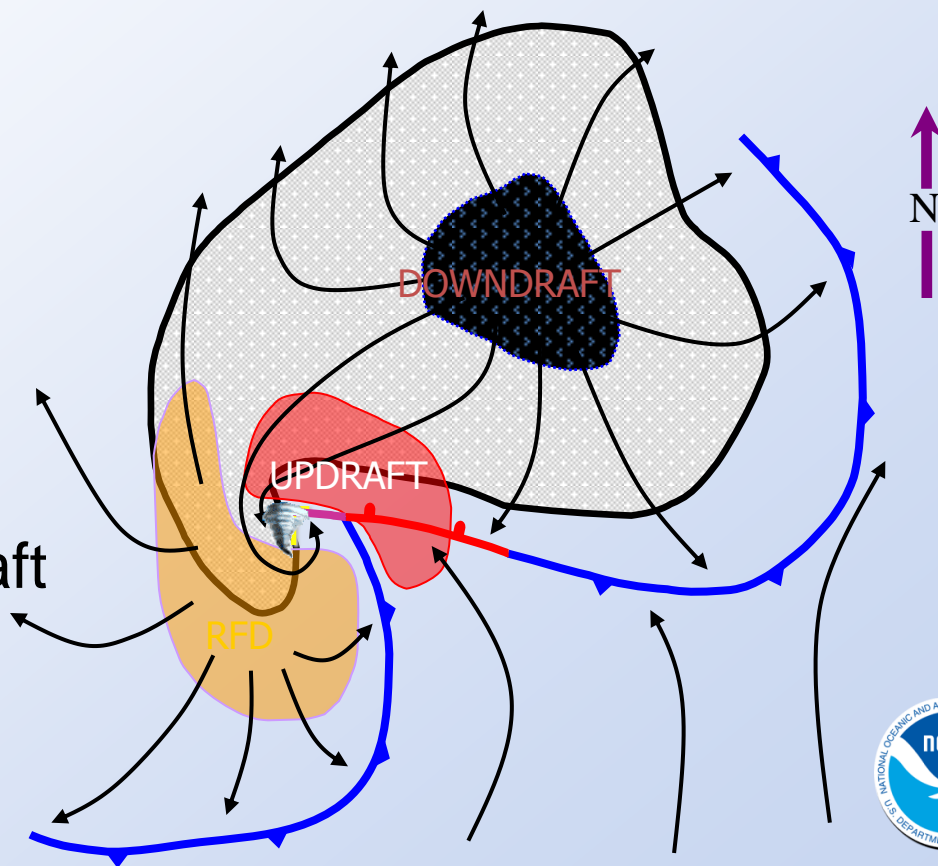
# Elite Spotter Outline

- **Review**
  - *Types of T'storms*
- **Tornadic Supercell**
  - *Classic, LP & HP Supercell*
  - *Wedge vs Rope Tornado*
  - *Rain wrapped Tornadoes*
- **Mesocyclone**
- **RFD & Tornadoogenesis**



# Rear Flank Downdraft

- Crucial to tornado development
- Downdraft on backside of updraft tower
- Wraps around updraft to tighten low-level circulation



(Top view)

# Supercell Thunderstorm

## 3 Types of Supercells

Classic



High Precipitation



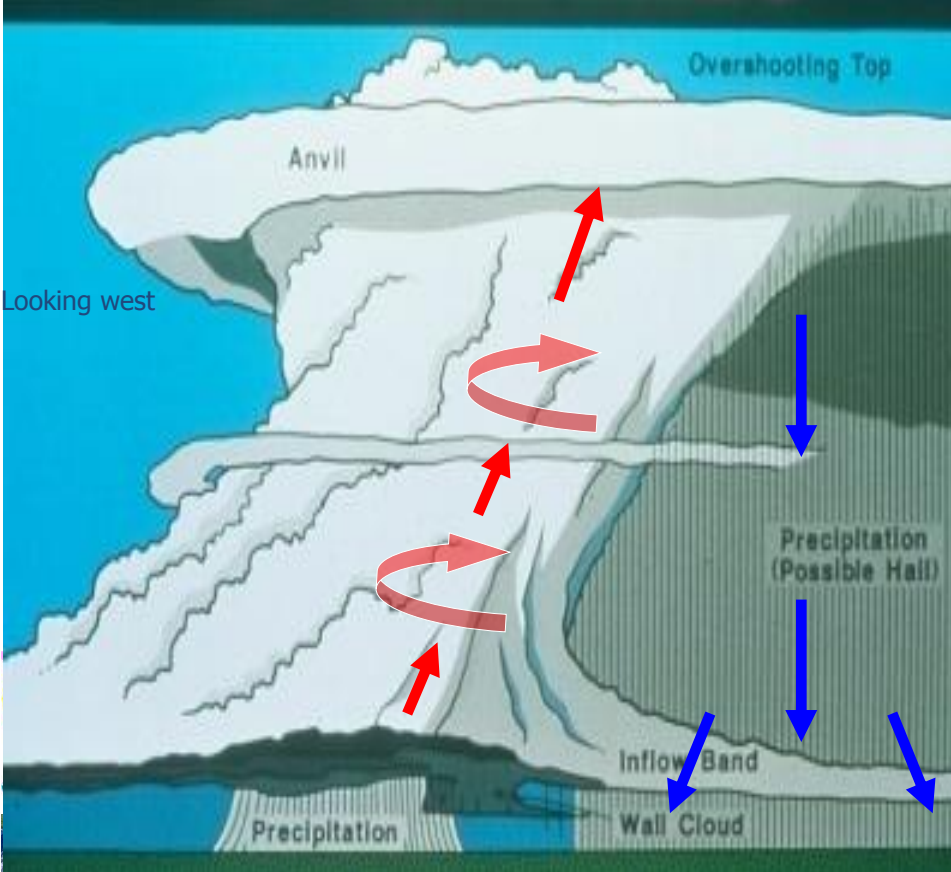
Low Precipitation



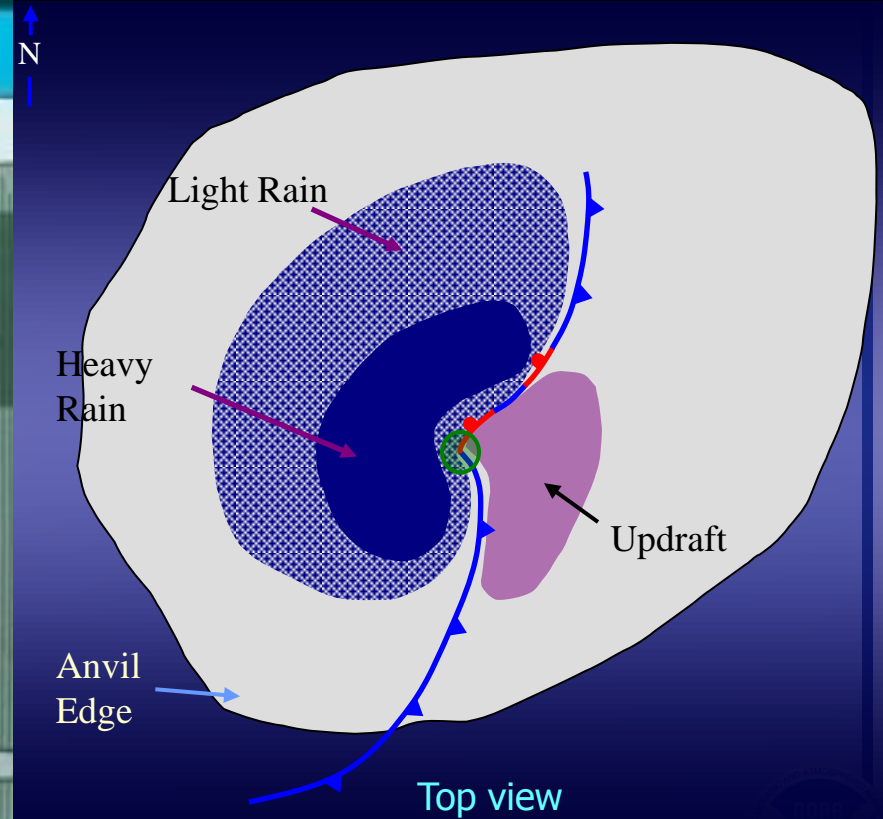


# HP Supercell

HEAVY PRECIPITATION SUPERCELL (b)



HP Supercell



Generally, there is not a good spot to view this type of storm since it is wrapped by a rain shield.

# HP Supercell



RFD

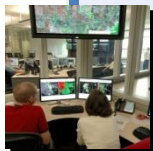
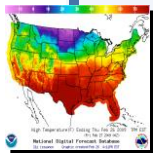
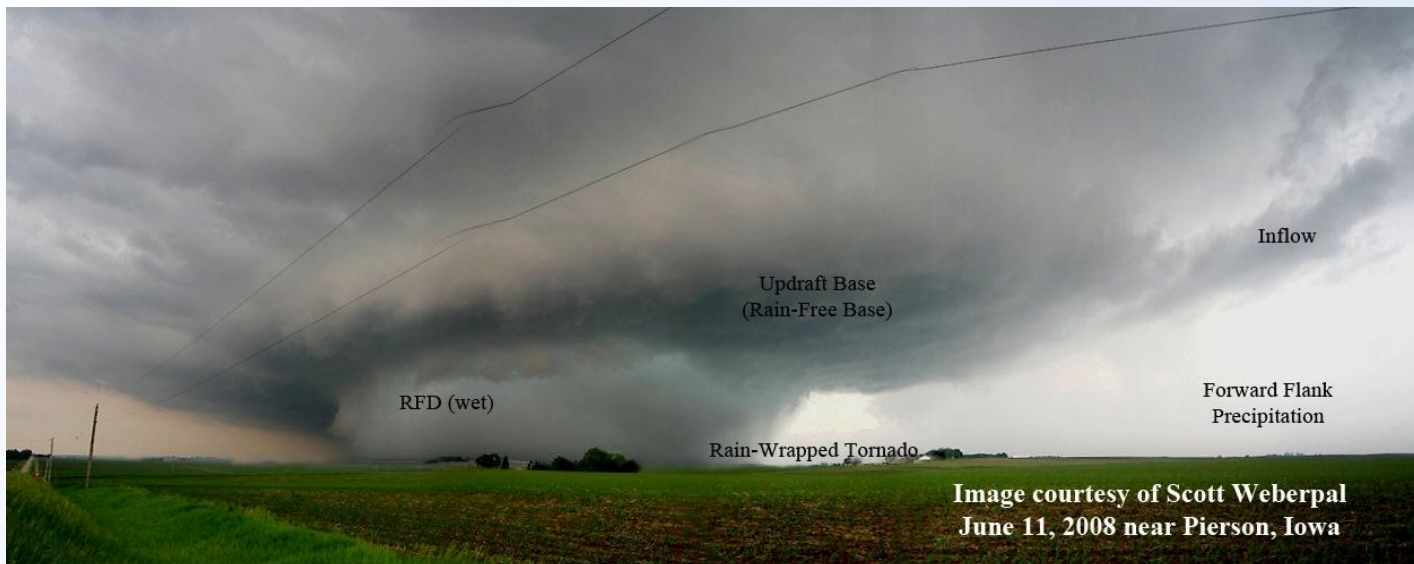
FFD



Tornado, just left of arrow, is hidden by RFD's heavy rain



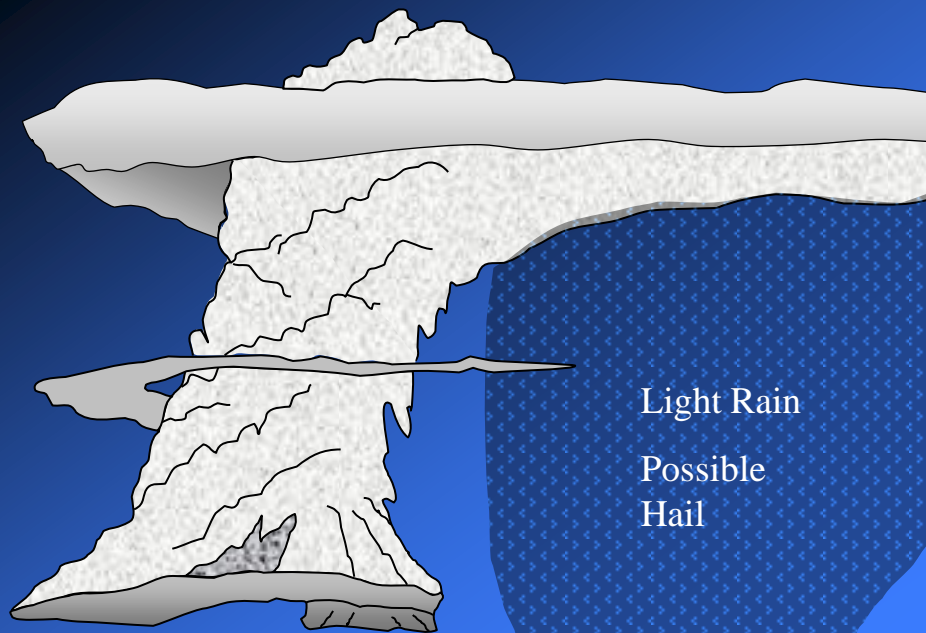
# HP Supercell (Hidden Tornado)





# LP Supercell

©2000 Roger Edwards



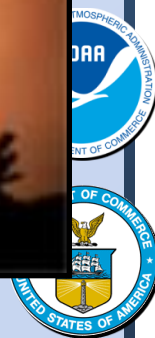
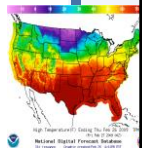
Light Rain  
Possible  
Hail





# LP Supercell

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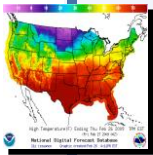


# Hard to see Tornado

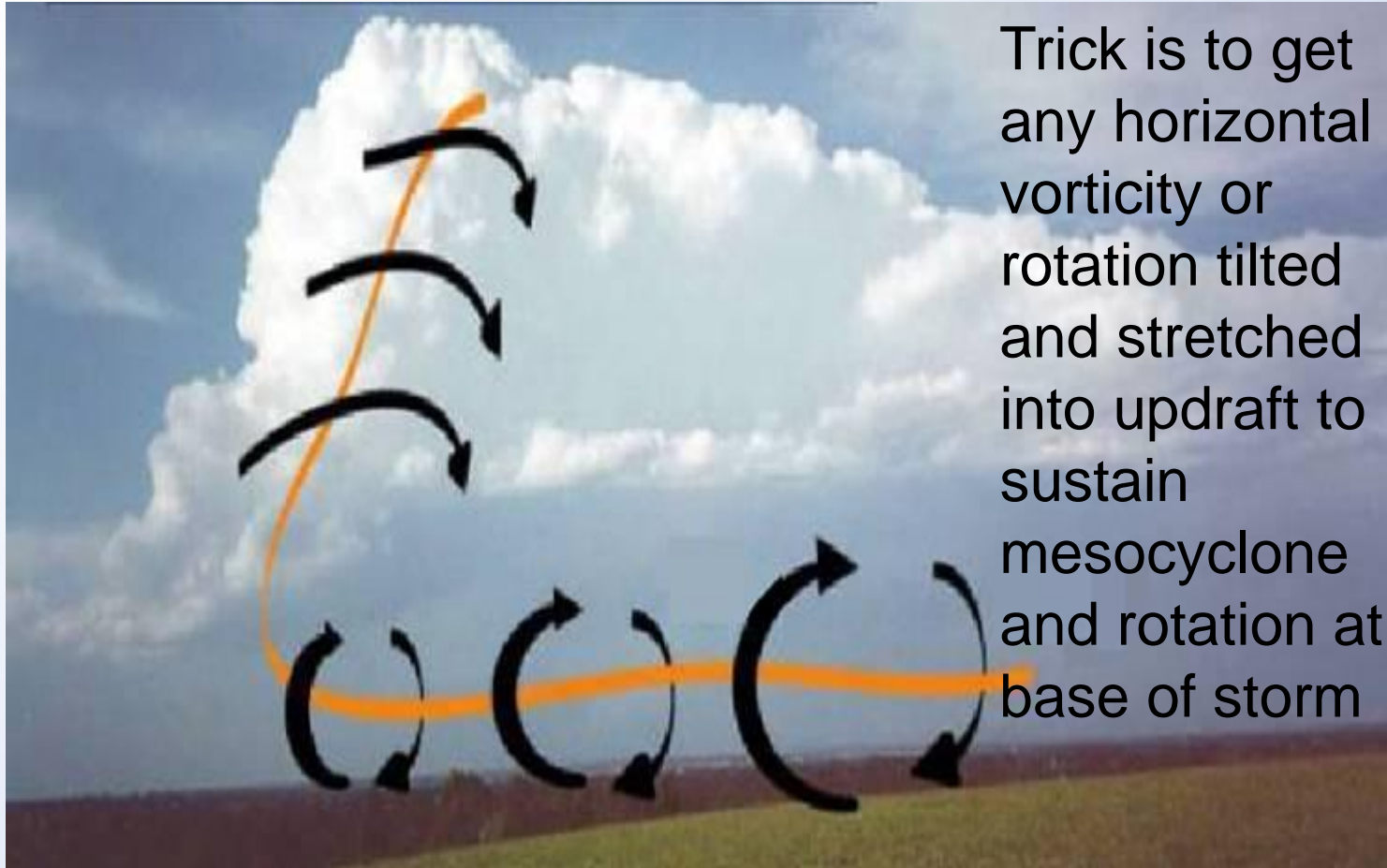
Tornado in Green  
& Rock Counties

May 30, 2004

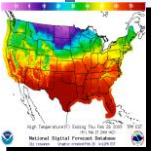
Credit - Chris Gullikson



# Horizontal Rotation Becoming Vertical Rotation

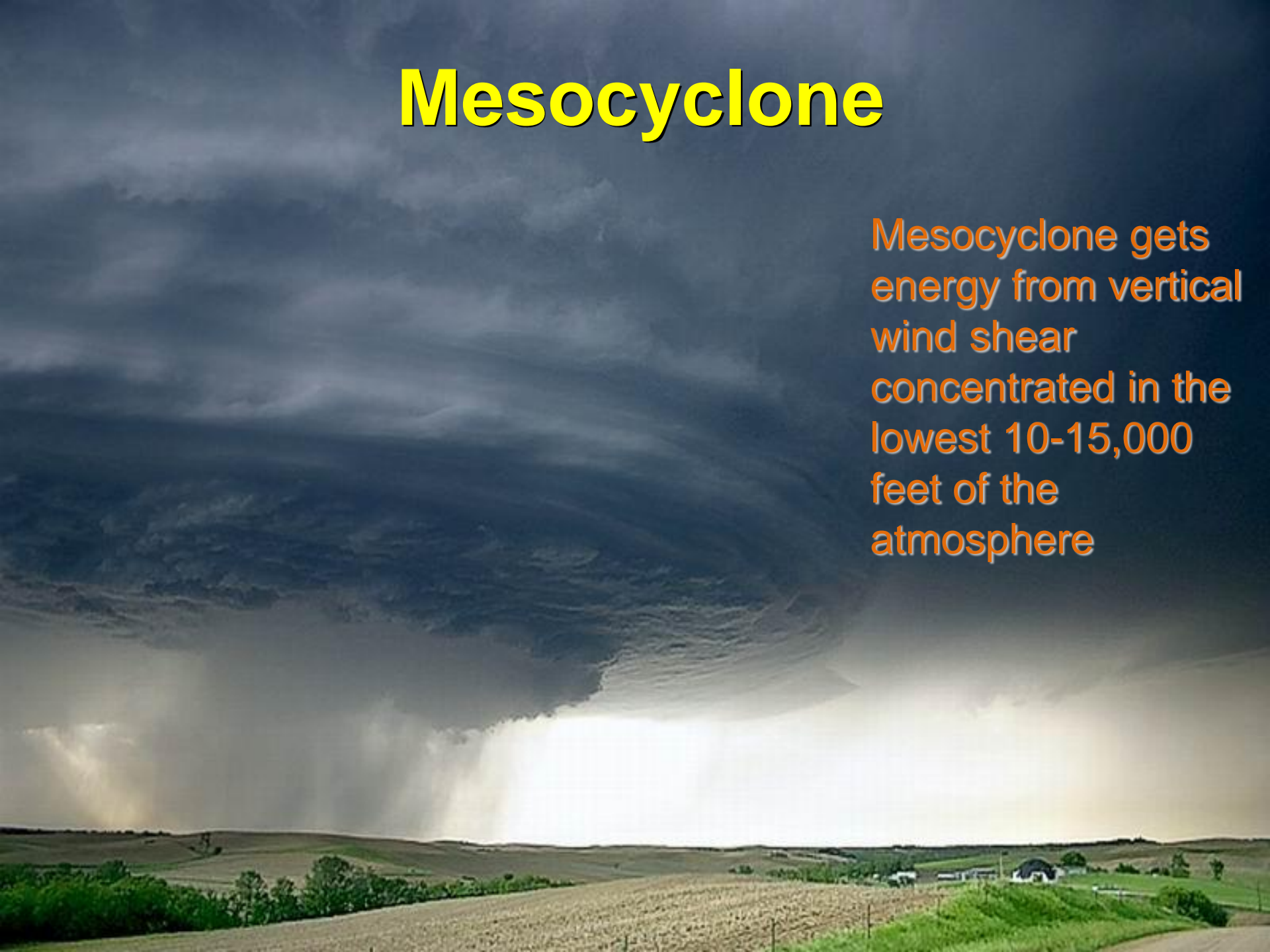


Trick is to get any horizontal vorticity or rotation tilted and stretched into updraft to sustain mesocyclone and rotation at base of storm



# Mesocyclone

Mesocyclone gets energy from vertical wind shear concentrated in the lowest 10-15,000 feet of the atmosphere





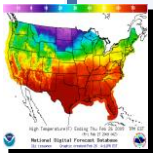
# Mesocyclone

Rotating updraft  
within the Rain-  
Free Cloud Base

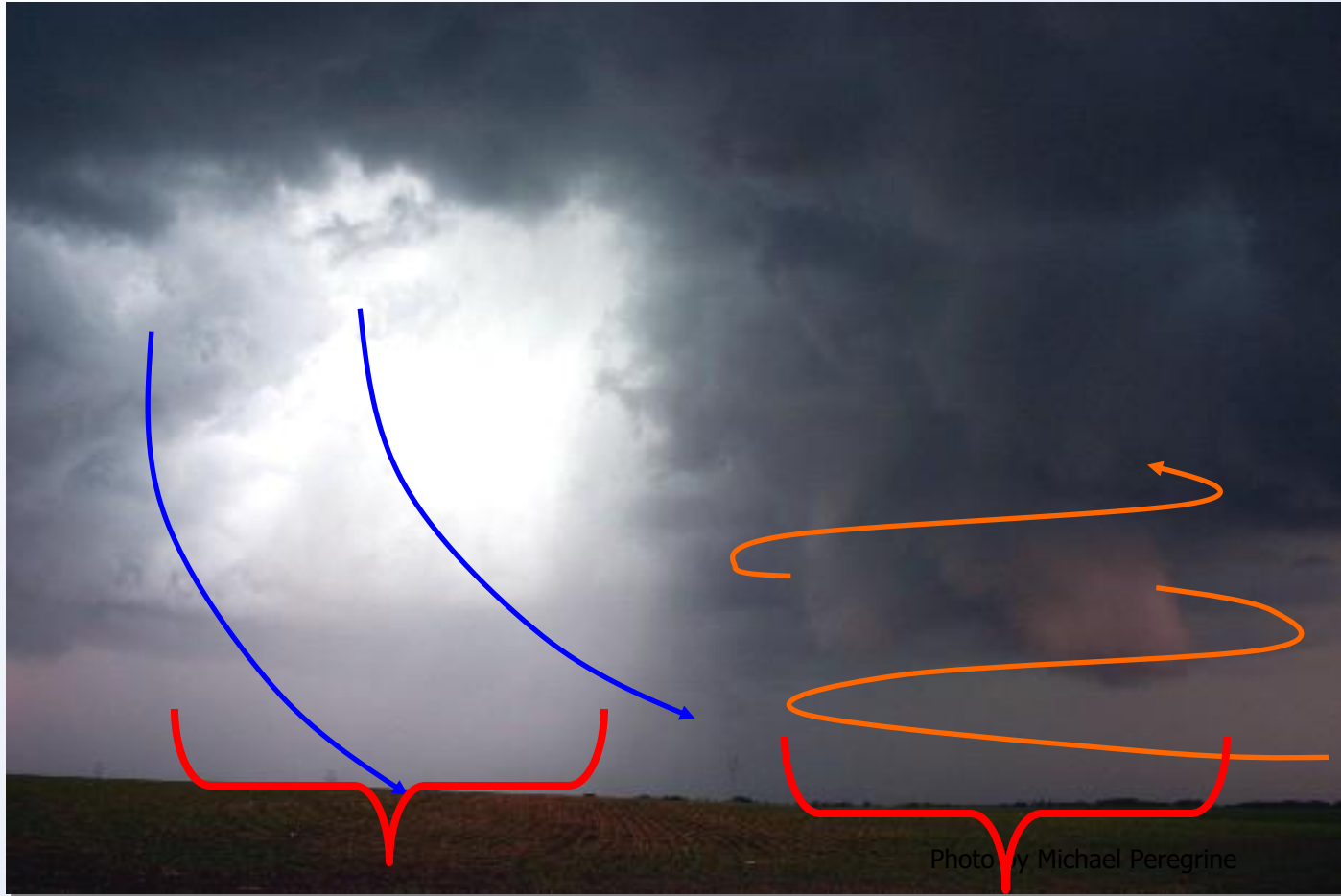
Present with all  
Supercells!



Research suggests no more than 20%  
of radar detected mesocyclones are  
associated with tornadoes



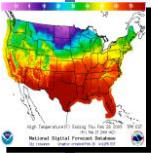
# Rear Flank Downdraft



RFD

Wall  
Cloud

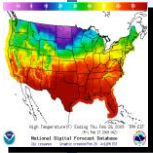
Photo by Michael Peregrine



# Rear Flank Downdraft

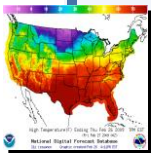


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# Understanding Tornadoogenesis

- In order to generate a tornado, a storm needs five basic things...
  - 1. Time – it must persist for an appreciable time (long-lived updraft that doesn't get choked by downdraft). Vertical wind shear (stronger winds aloft) pushes (tilts) the updraft over.
  - 2. Most of wind shear needs to be concentrated in the lowest 10-thsd feet of the atmosphere – rotation results (mesocyclone).

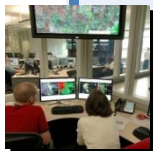
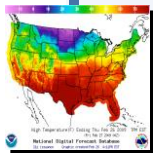




# Understanding Tornadoogenesis

## ➤ And...

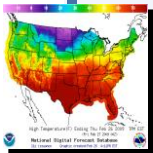
- 3. Forward Flank Downdraft (FFD) needs to generate a low-level boundary on it's south side which then allows for local generation of horizontal vorticity (rotation) that can be tilted and stretched vertically in the updraft area of the storm
- 4. Rear Flank Downdraft needs to curl around the rotating wall cloud and transfer torque to the pre-existing rotation, and it needs to have sufficient buoyancy (not too cool) so part of it can take another ride up into the updraft.

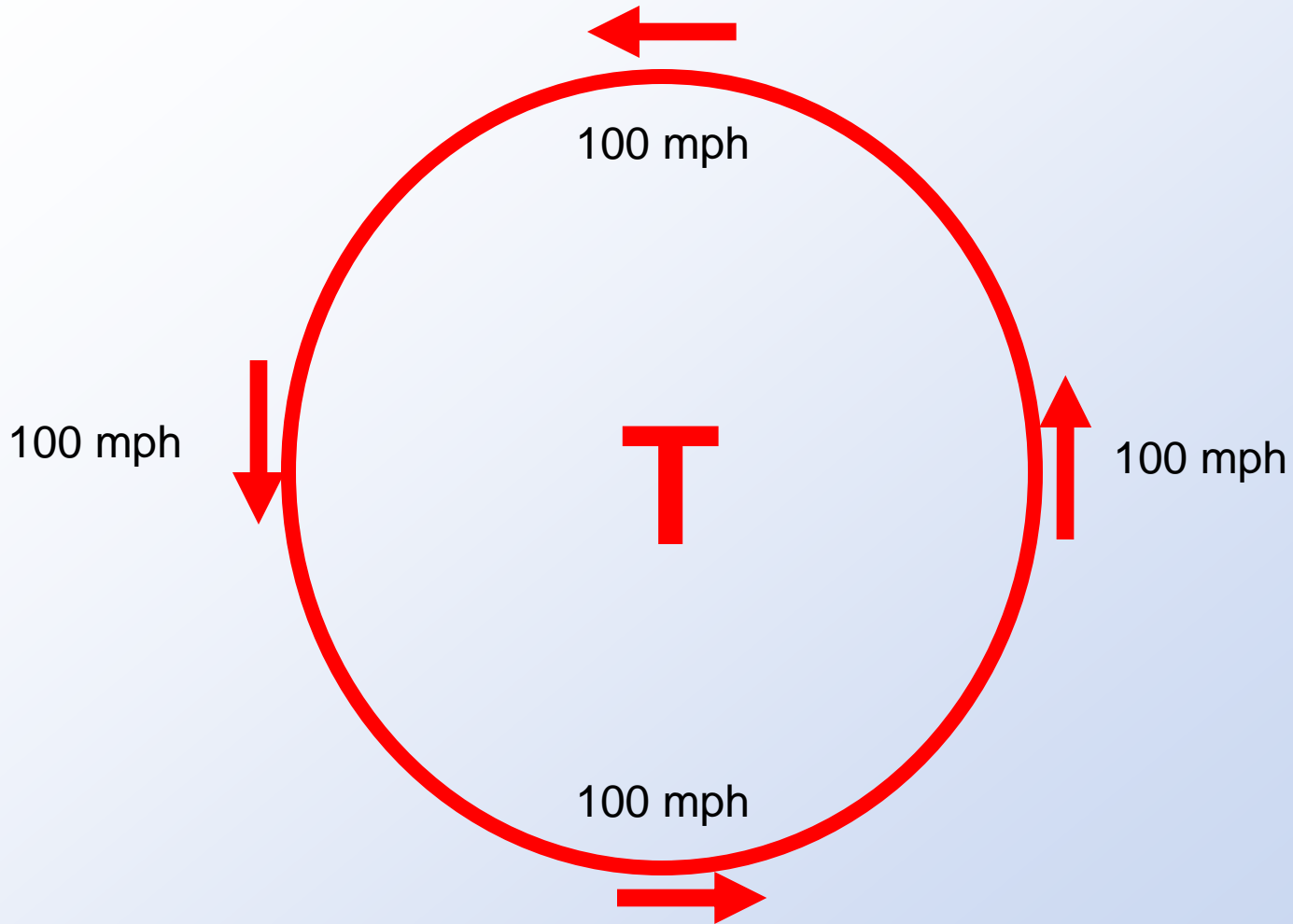


# Understanding Tornadoogenesis

## ➤ And...

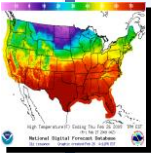
- 5. Speed of wind impinging on storm can't be too strong – otherwise RFD will have difficulty developing. We're talking about the entire depth of the storm cloud – some of the air outside of the storm does mix in. In order to generate a tornado a storm doesn't need extreme wind shear or extreme buoyance (CAPE) – it just needs a balance of the two.



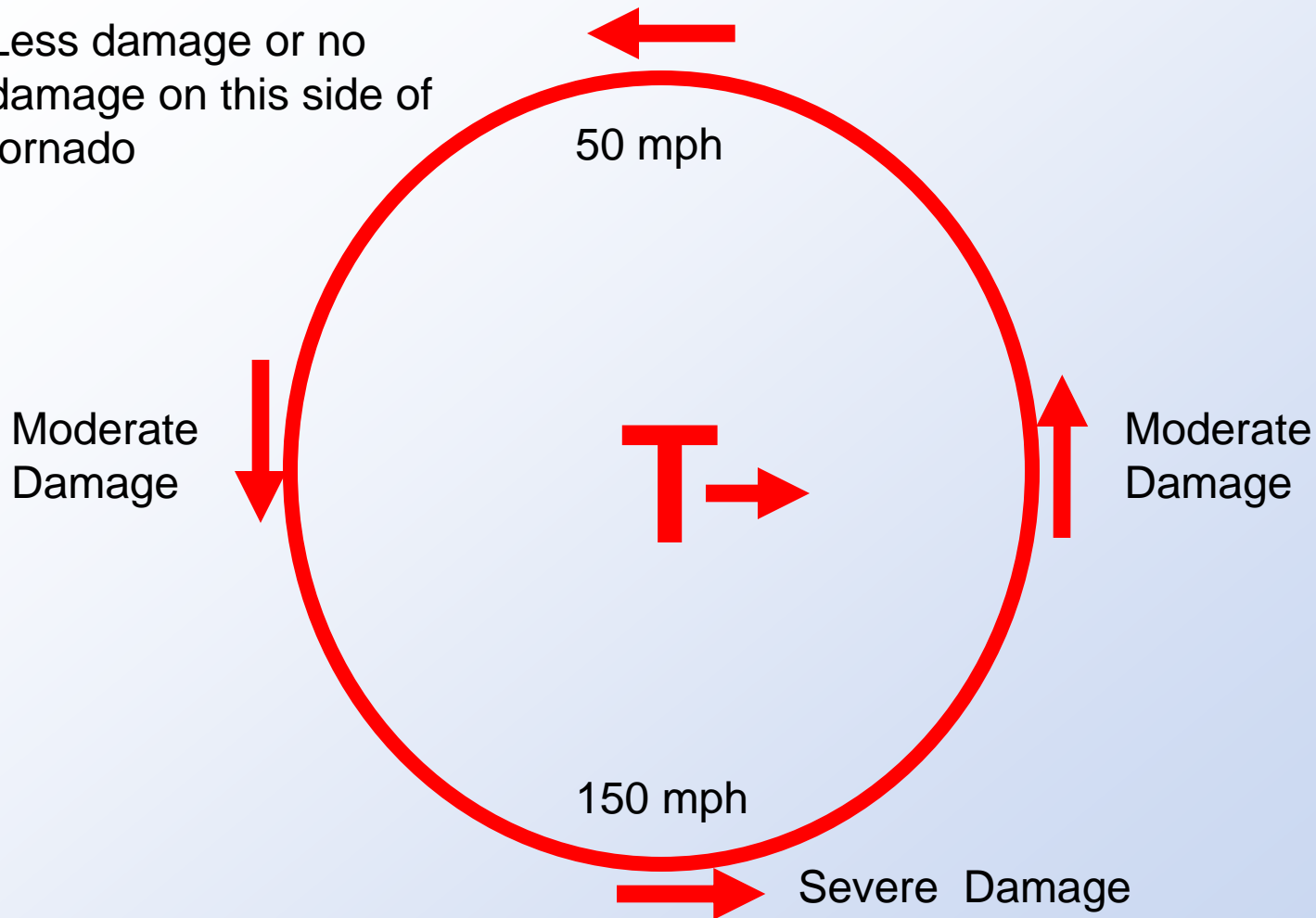


**Cyclonic Winds – relative to tornado – “Storm Relative Motion (SRM)”**

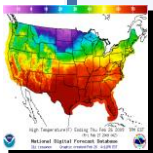
**If tornado were stationary, damage roughly equal on all sides**



Tree Branch Damage?  
Less damage or no  
damage on this side of  
tornado



**Tornado moving east at 50 mph.  
Plotted wind speeds reflect what is felt at ground level.  
Cyclonic Winds – relative to ground – “Base Velocity” (VEL)**

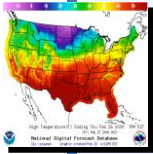




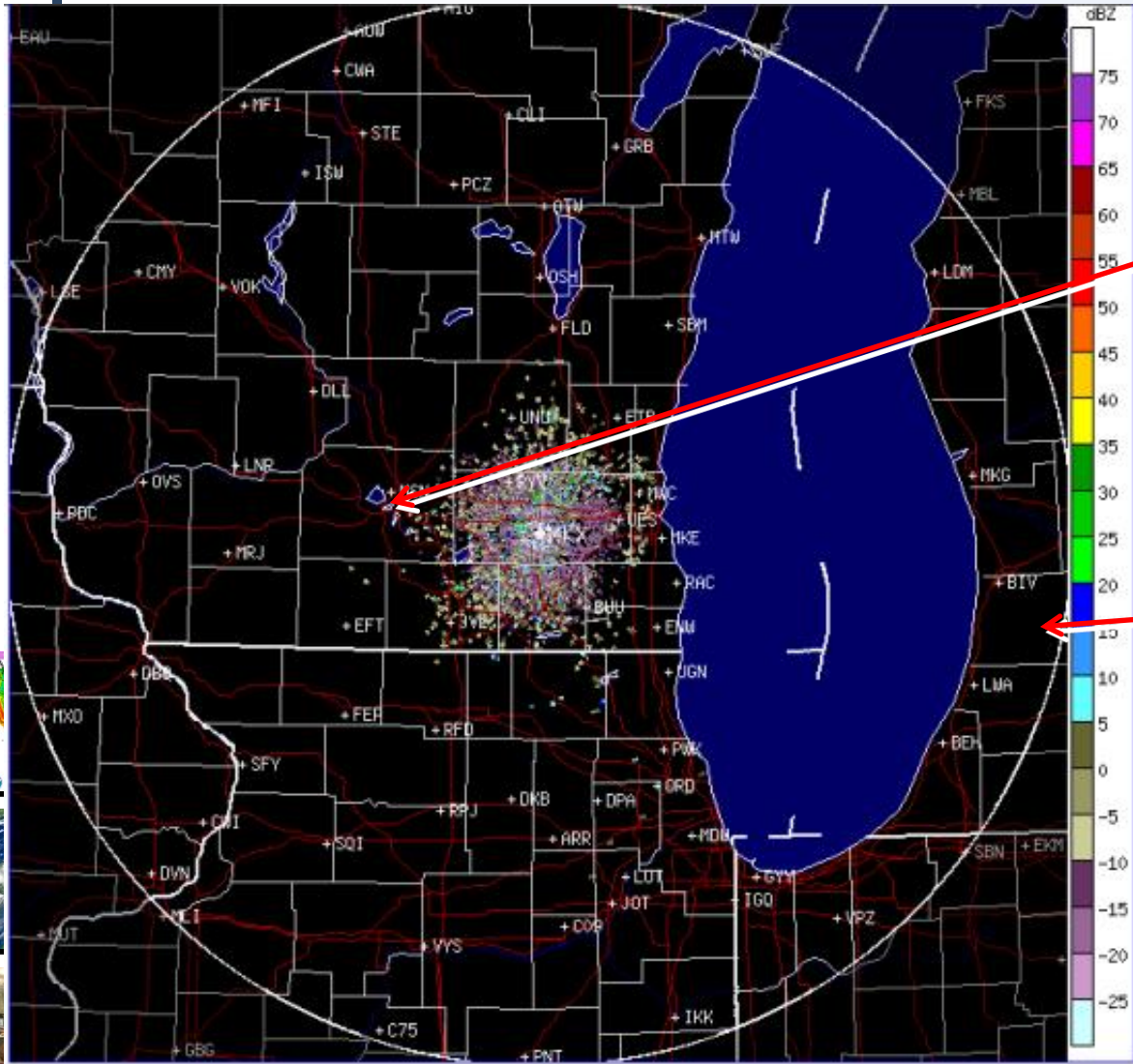
# Radar



# Interpretation



# Radar Interpretation

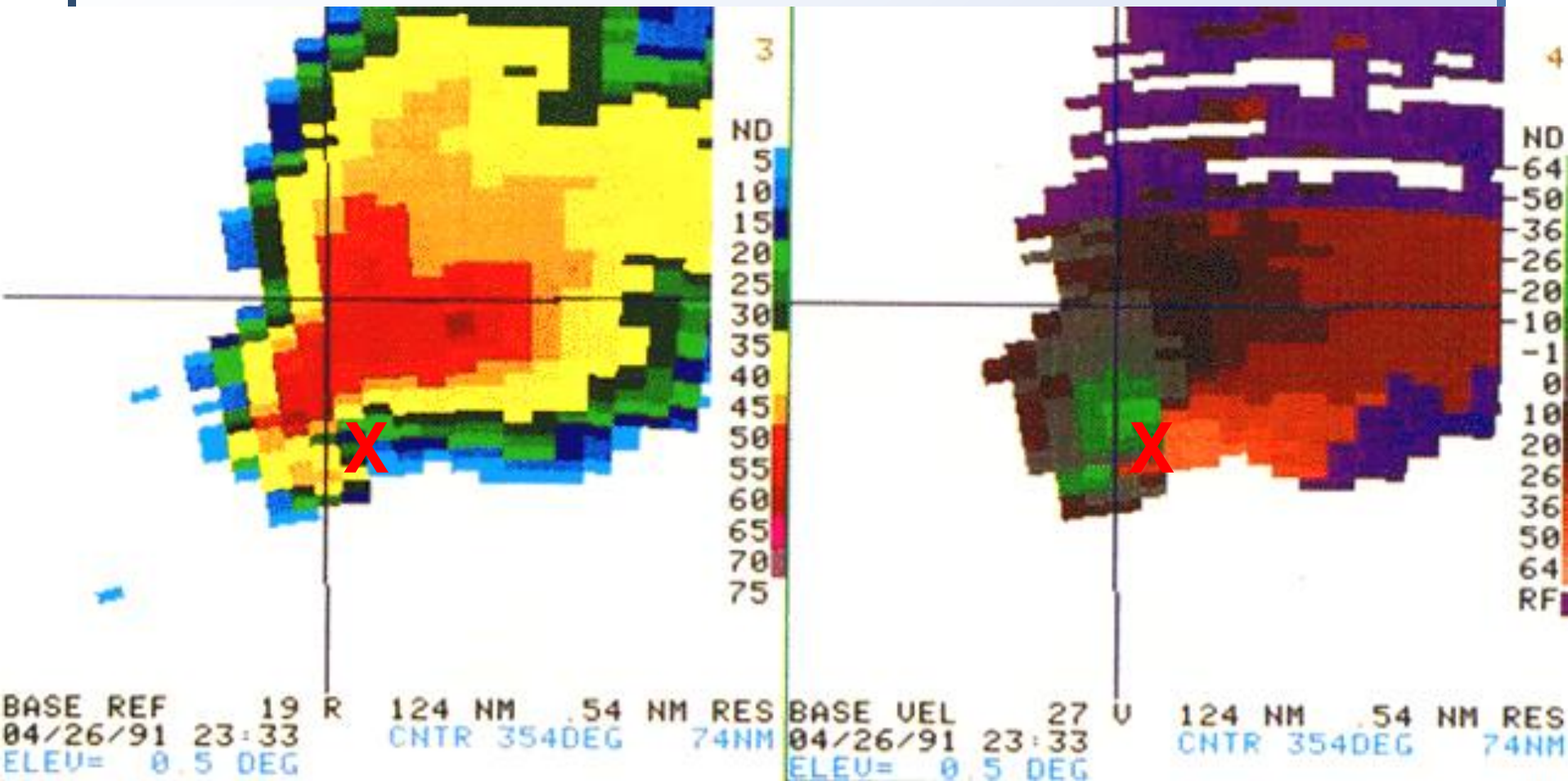


Beam is 5 thsd  
feet AGL

Beam is 17 thsd  
feet AGL

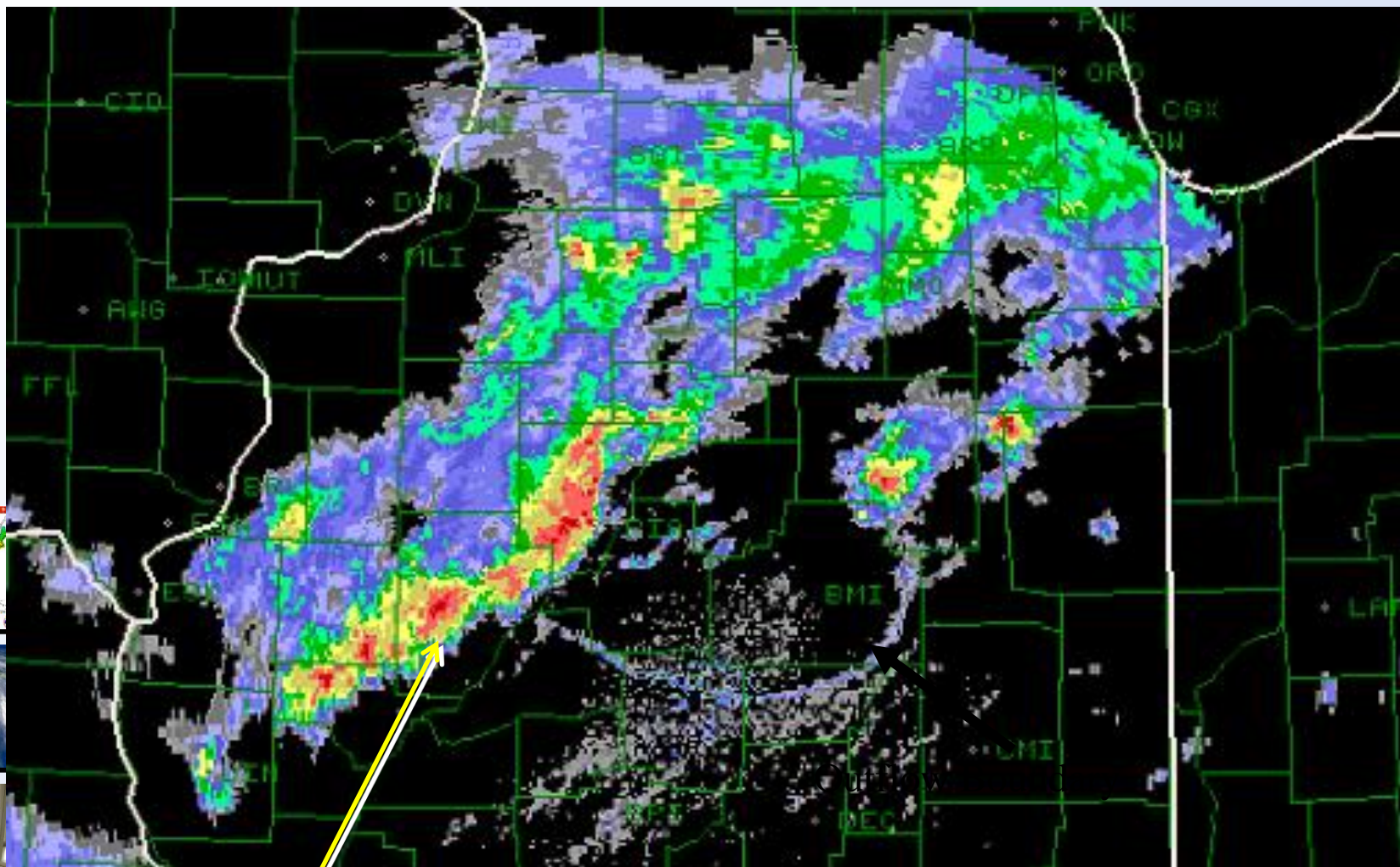


# Classic Supercell

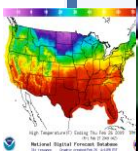




# Outflow Boundaries



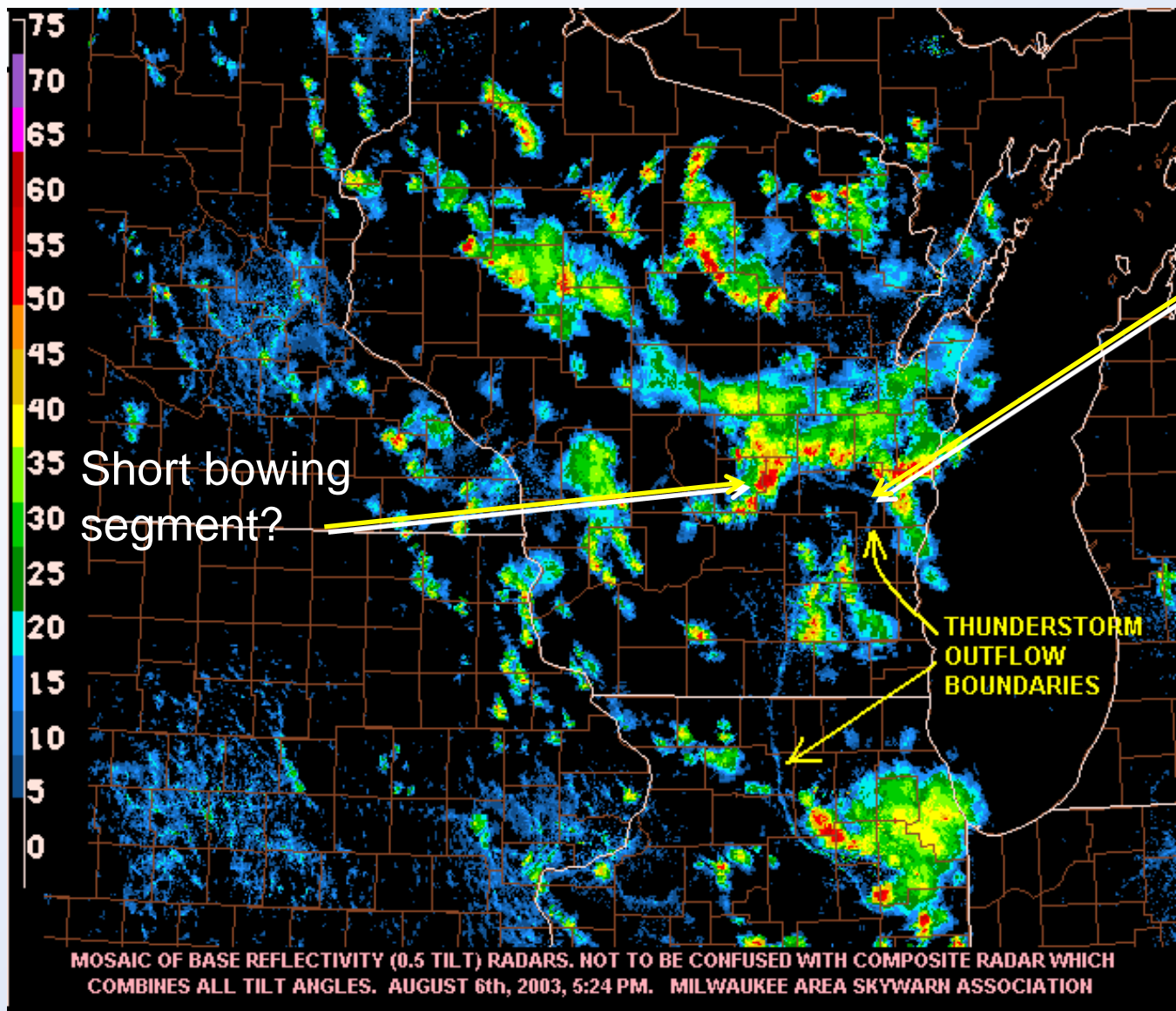
Squall Line





# Outflow Boundaries

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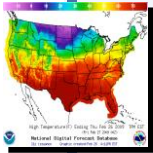
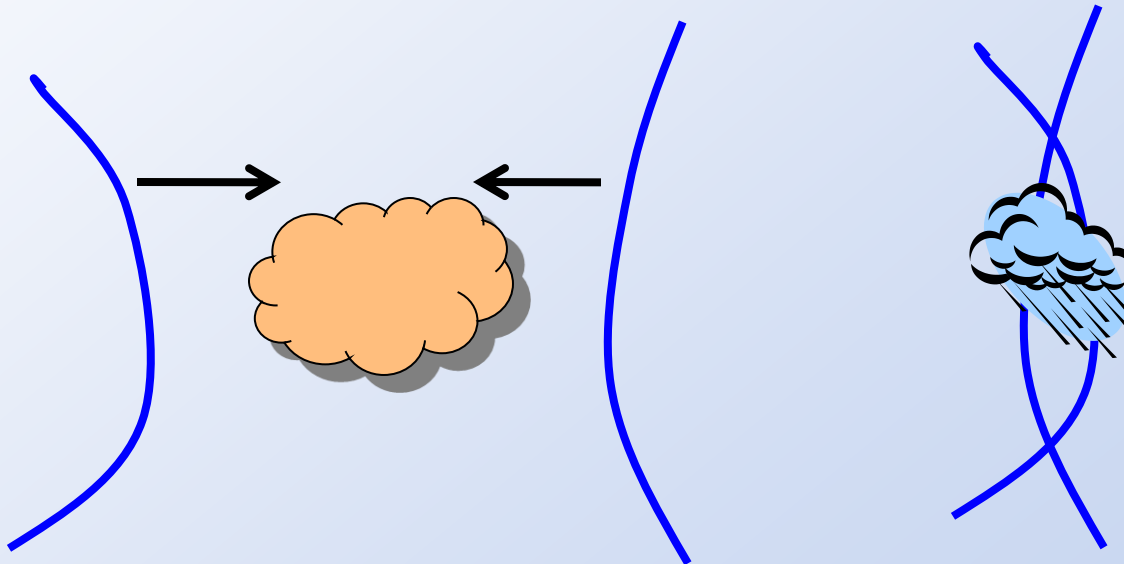


Triple Point



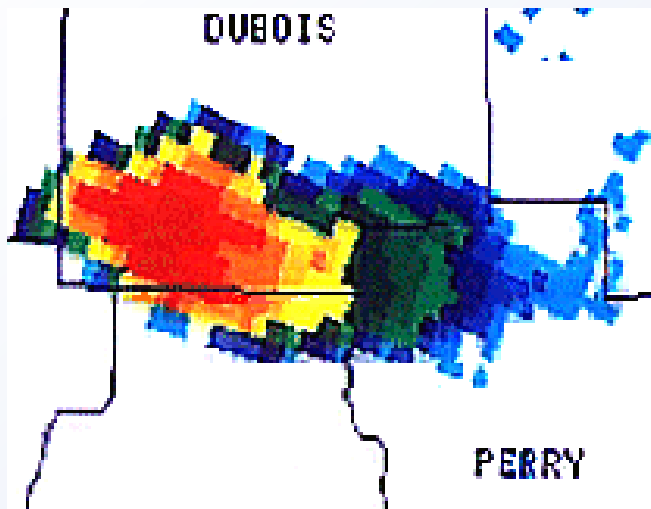
# Storm Intensification

If two outflow boundaries approach from different directions, when they intersect and collide, watch for new storms or intensification of existing storms in the region of the collision.

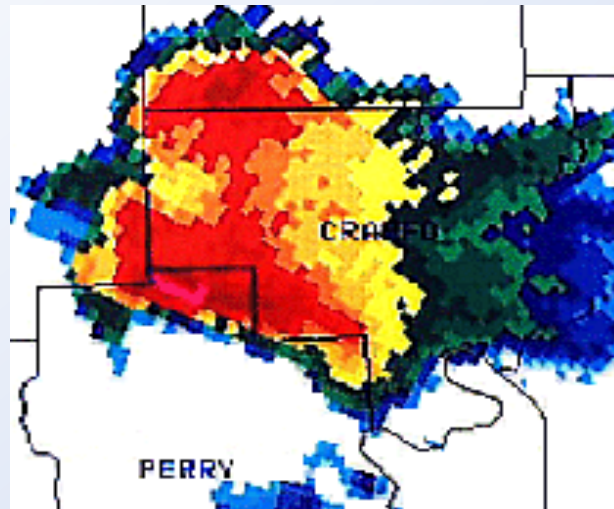


# Storm Splitting

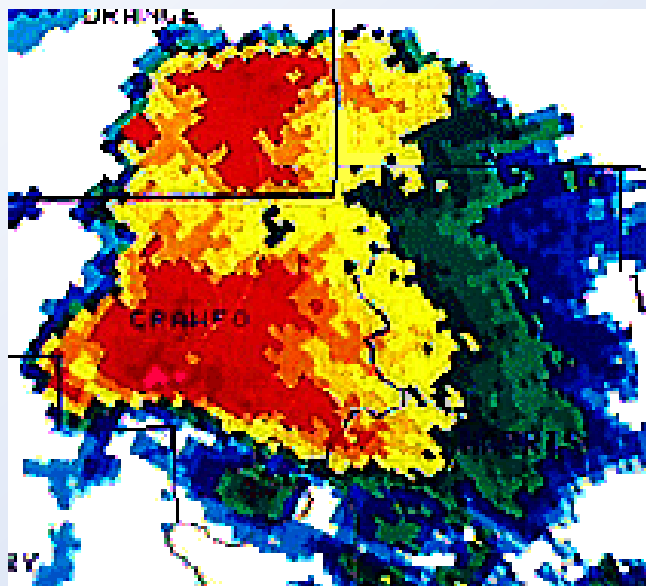
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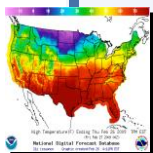
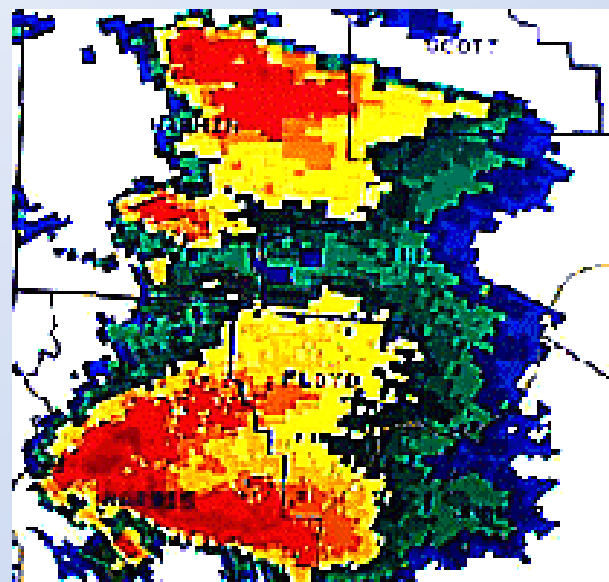
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3

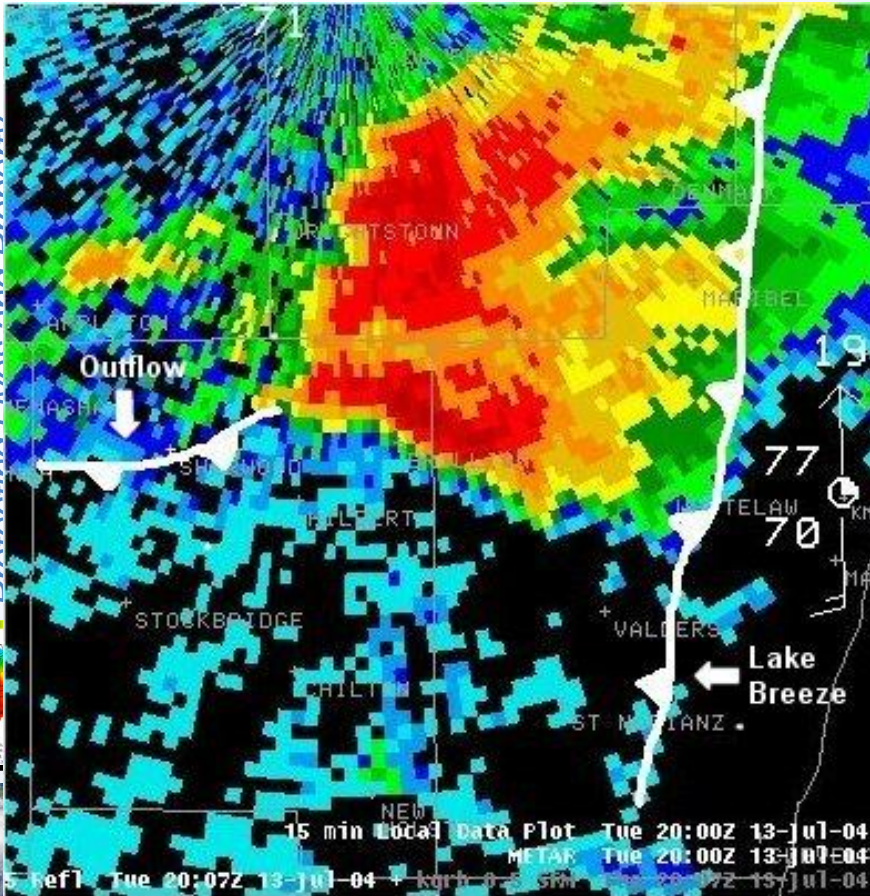


4





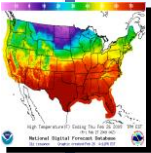
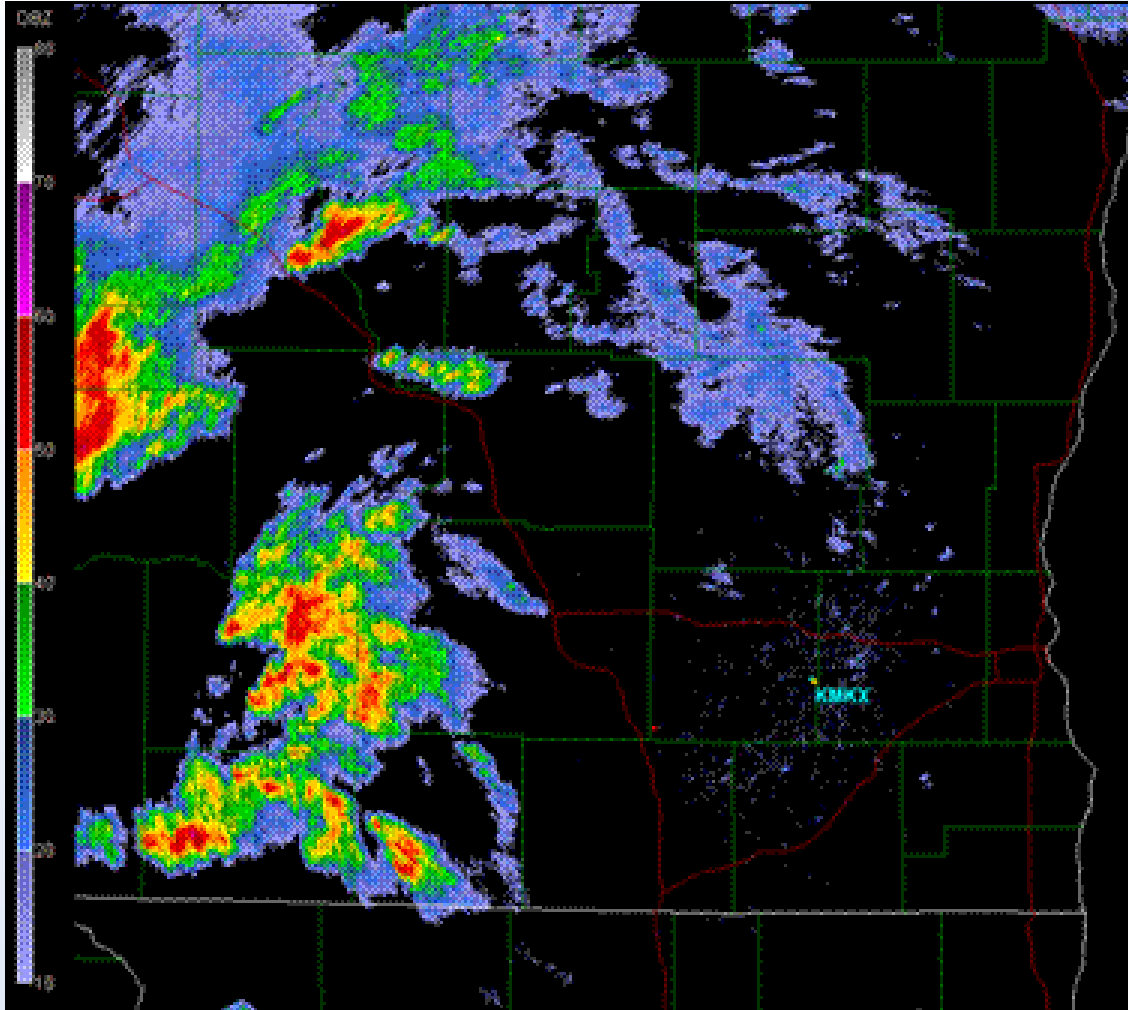
# Cell Merger



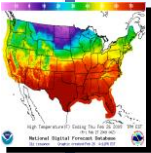
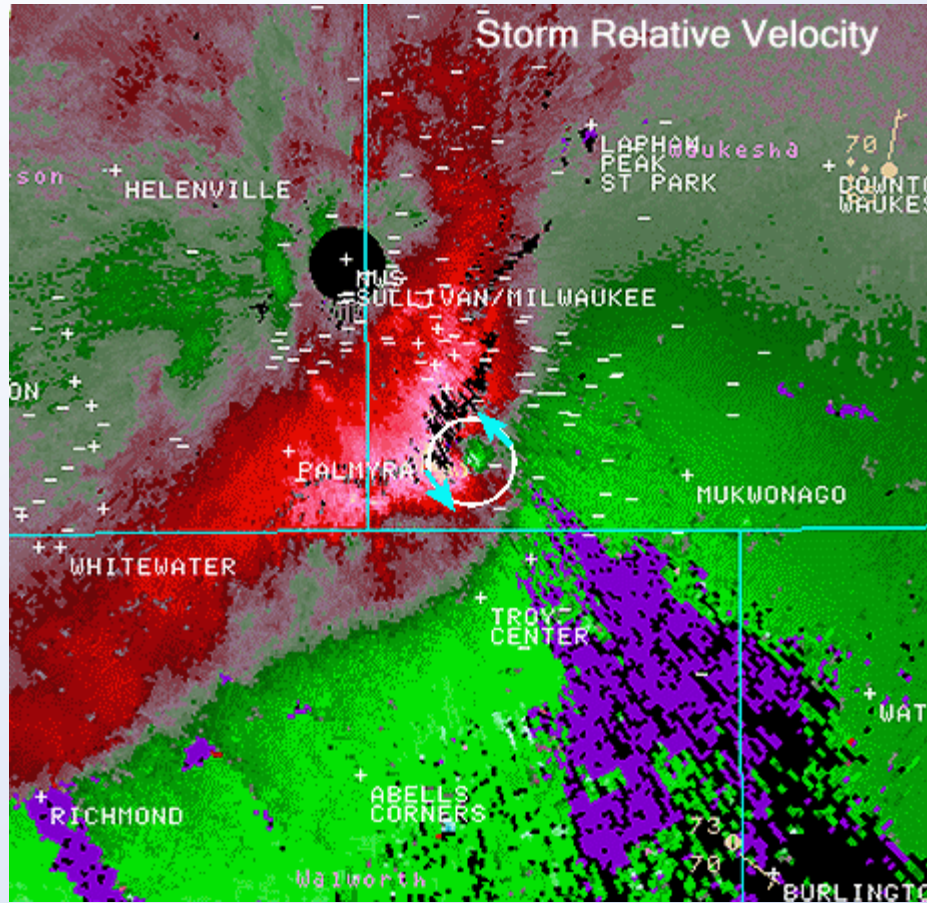


# June 21, 2010

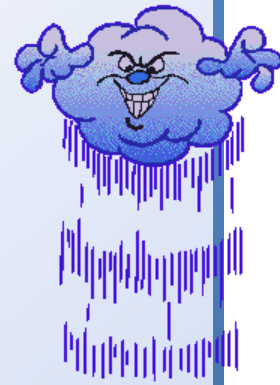
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# June 21, 2010



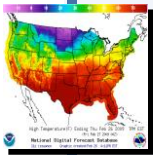
# June 21, 2010



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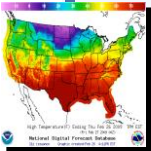


## Eagle, WI Damage



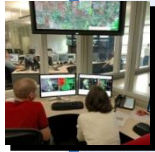
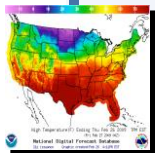
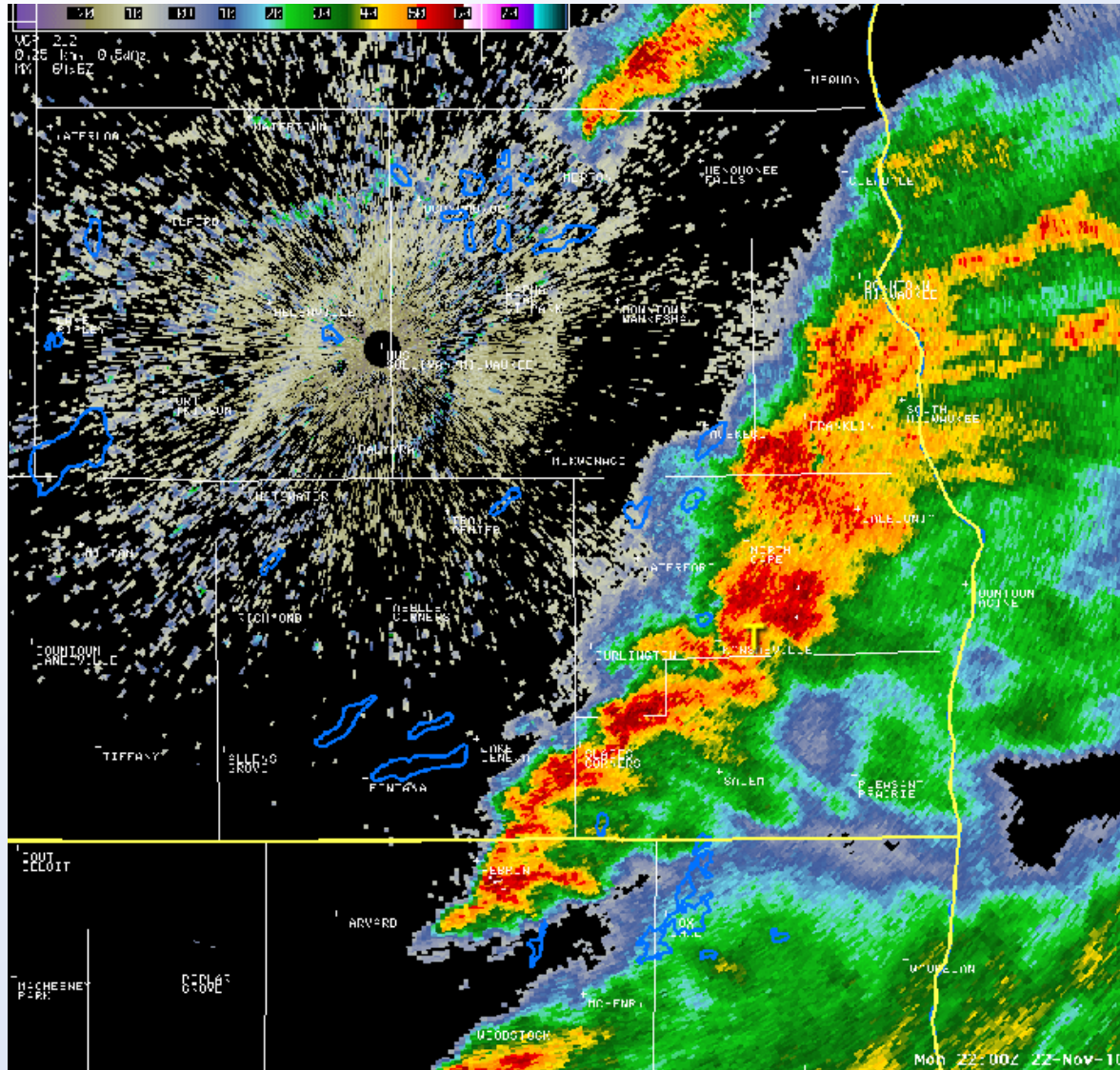
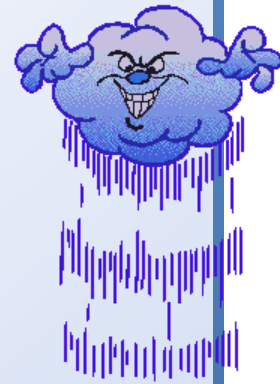


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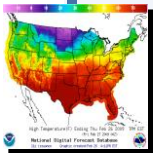
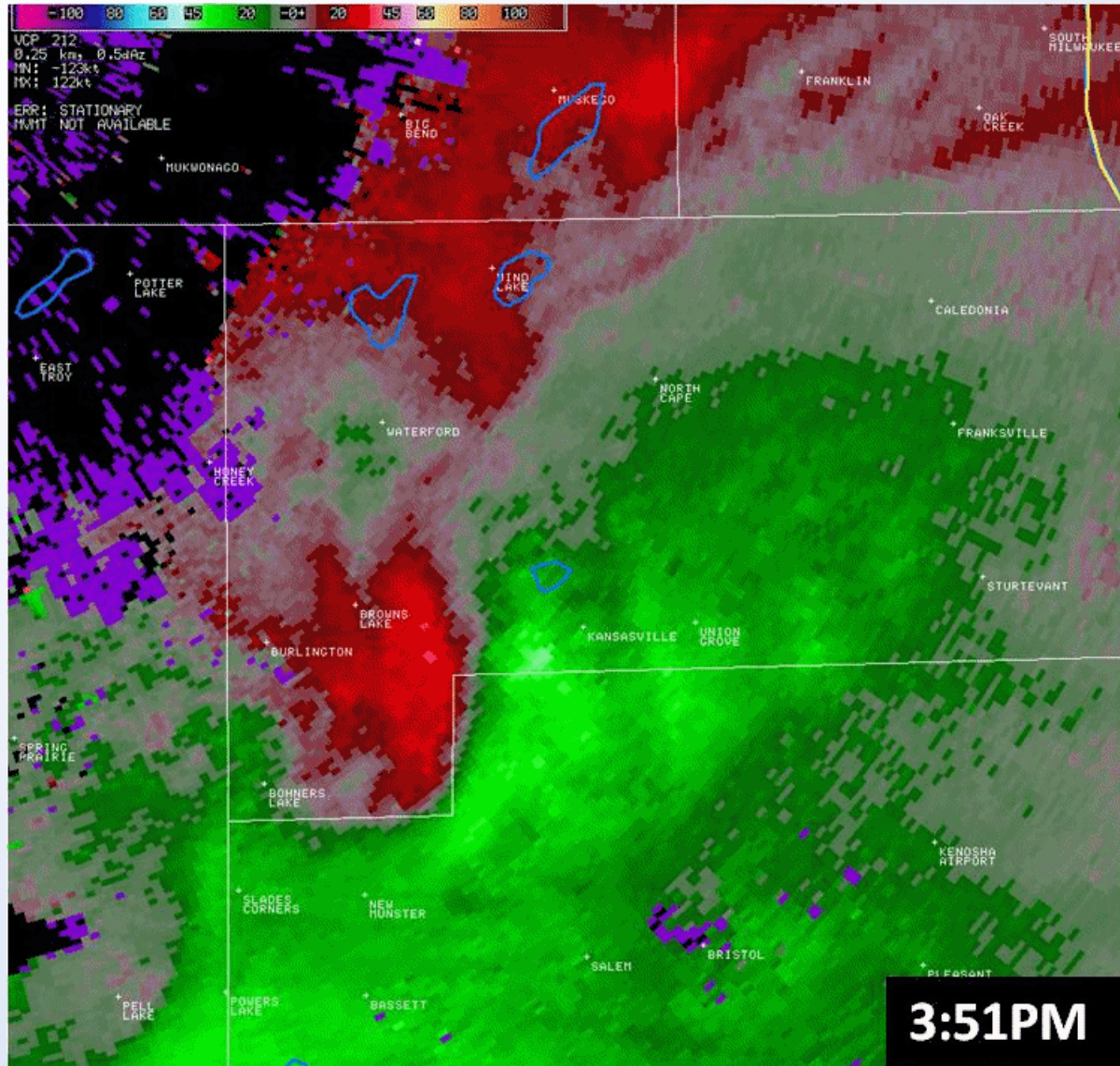
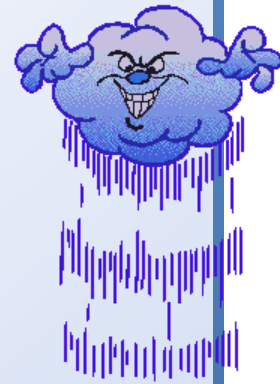


# November 22, 2010

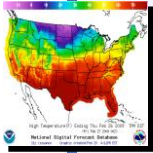
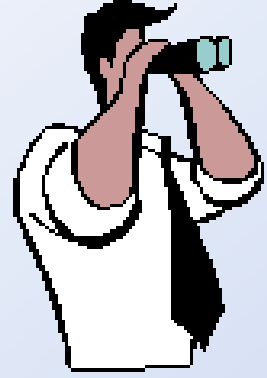




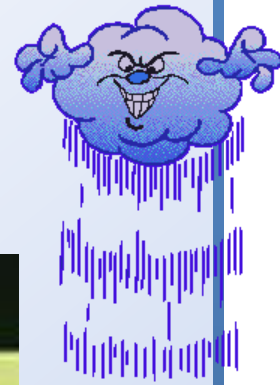
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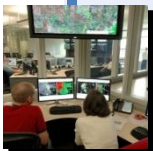
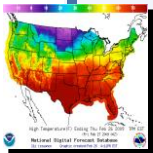
# Cyclic Supercell



# Cyclic Supercell



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# Greensburg Cyclic Supercell

Rating: EF3 (strong)  
 Duration: 65 min.  
 Length: 23.5 mi  
 Mean Width: 1.5 mi  
 Max Width: 2.2 mi  
 Damage Area: 35.4 mi<sup>2</sup> (A5)  
 Damage \$\$: 1.5 M

Rating: EF3  
 Duration: 24 min.  
 Length: 17.4 mi  
 Mean Width: 0.6 mi  
 Max Width: 0.9 mi  
 Damage Area: 9.7 mi<sup>2</sup> (A4)  
 Fatalities: 1

Rating: EF5  
 Duration: 65 min.  
 Length: 28.8 mi  
 Mean Width: 1.1 mi  
 Max Width: 1.7 mi\*  
 Damage Area: 32.9 mi<sup>2</sup> (A5)<sub>1</sub>  
 Fatalities: 11  
 Damage \$\$: 250 M

Rating: EF3 (strong)  
 Duration: 58 min.  
 Length: 18.2 mi  
 Mean Width: 0.9 mi  
 Max Width: 1.2 mi  
 Damage Area: 15.6 mi<sup>2</sup> (A4)  
 Fatalities: 1

